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Fertilizer, Manure and Management Practices

Recommended for the Regional Soils in Manitoba

By

THE MANITOBA FERTILIZER BOARD

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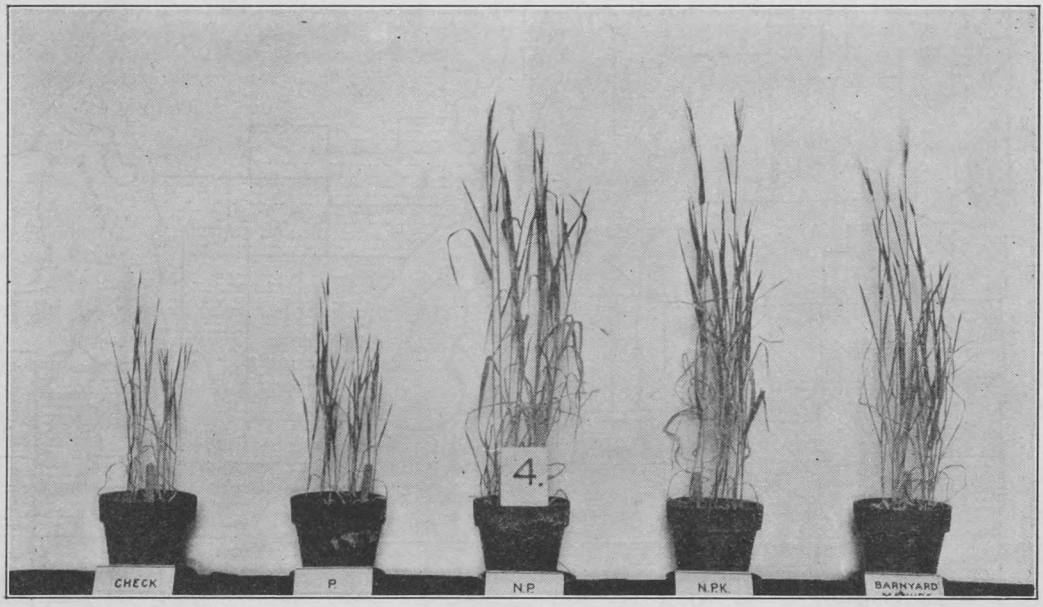
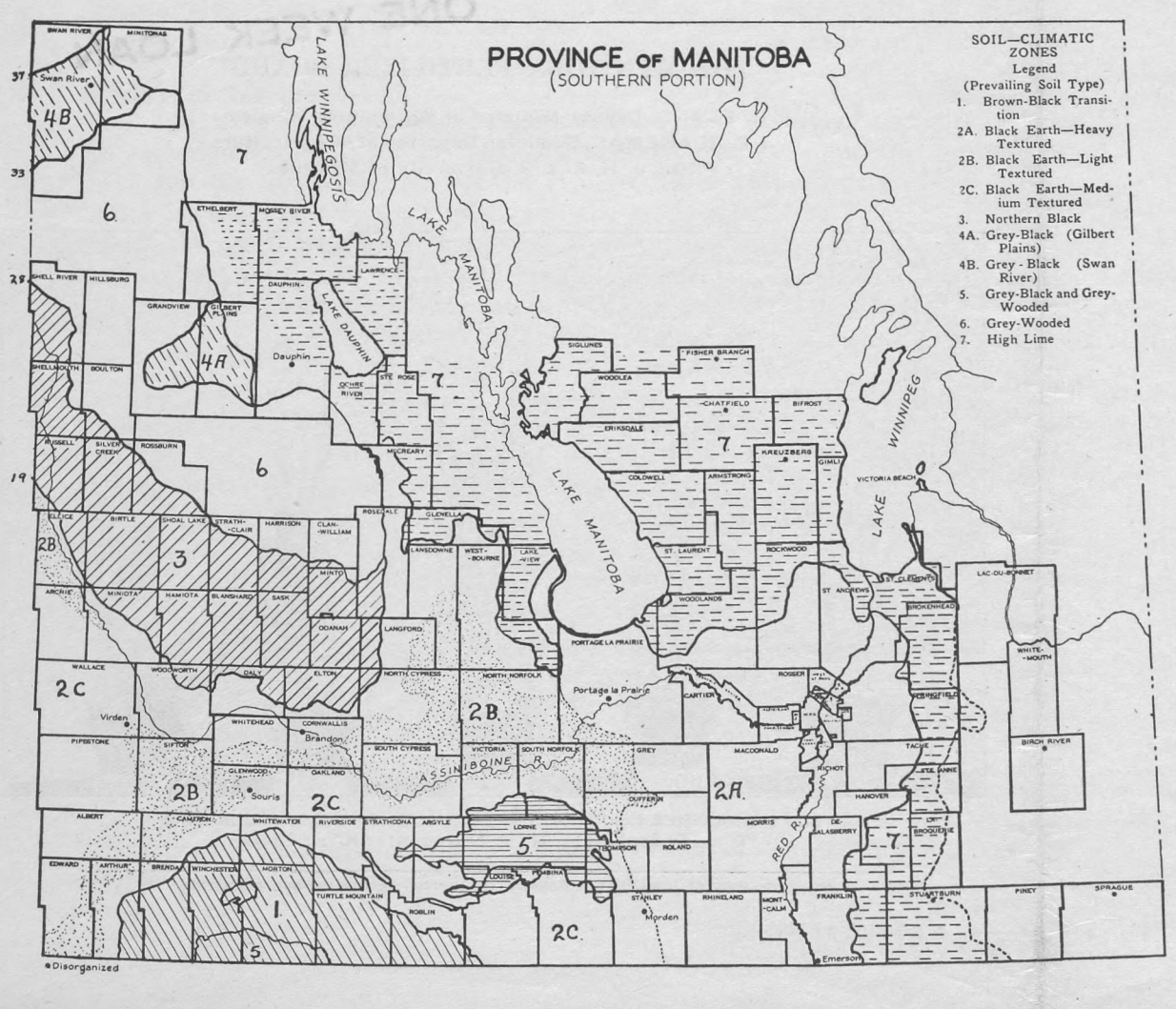


Soil from drifted field showing response to fertilizer and manure
"P" = Phosphate; "N" = Nitrogen; "K" = Potash

By Authority of Hon. D. L. Campbell, Minister of Agriculture and Immigration

SUMMARY OF FERTILIZER, MANURE, AND MANAGEMENT PRACTICE

Soil Zone	FERTILITY TREATMENT LIKELY TO BE REQUIRED	Fertilizer, Manure, and Soil Treatme		
		FALLOW	GRAIN CROPS **	INTERTILLED CROPS
1—"Brown-Black" Soils.	Naturally fertile, but organic matter may be required, especially where it has been depleted by wind erosion.	1—Commence operations as soon as previous crop is removed. 2a–Use trash cover of long stubble, straw, or crop residue. b–Alternative method: Sow grain in one foot drills and cultivate out to provide trash cover. 3—Use corn in wide spaced rows for wind protection. 4—Prevent weeds from using up the available moisture. 5—Early in the winter make snow banks with snow plow or "V" drag, to catch and hold snow.	1—Drill ammonium phosphate* in with the seed at 25 to 30 pounds per acre, as required, and if moisture is present. 2—Surface work for moisture control as soon as crop is harvested, leaving stubble on the surface for trash cover. 3—Apply barnyard manure to the knolls. 4—Work all fields crosswise of the slope.	1—Barnyard manure; or as alternative ammonium phate* at 35 to 45 pounds per acre applied with lizer attachment, but not in contact with the see
2—"Black-Earth" Soils. (2A; 2B; 2C.)	1—Phosphate. 2—Addition of organic matter to light textured and wind-blown soils.	1—General. Similar to Zone 1. 2—For heavy soils: Use sweet clover plowed in early summer to improve soil tilth, and fallow from July to freeze-up. 3—For light soils: Use fallow substitutes, (example-corn) or keep under trash cover.	1—Drill ammonium phosphate* in with seed at 25 to 35 pounds per acre. 2—Fall cultivation for annual weed control. 3—August plow for sow-thistle control.	1—Barnyard manure, 10 to 12 tons per acre (gener or 2—For corn sown with planter, 40 to 50 pounds amm phosphate* applied at side or above with fe attachment. 3—For sugar beets, 65 pounds ammonium phosphat not in contact with seeds) and use clover in ro 4—For potatoes, 120 pounds ammonium-phosphate, pounds 9-27-9 per acre applied as side band appli
3—"Northern Black-Earth" Soils.	1—Ammonium Phosphate. 2—Barnyard manure on knolls and higher land where soils are relatively shallow.	1—Work land crosswise of slopes to reduce run-off and erosion. 2—Stubble land should be fall cultivated for annual weed control prior to fallow. 3—Sweet clover and partial fallow may be used as fallow substitute in normal seasons.	1—Ammonium phosphate* drilled in with seed at 30 to 40 pounds per acre.	Plow in barnyard manure at 12 tons per acre in t prior to planting.
4—"Grey-Black" Soils. (4A; 4B.) and 5—"Grey-Black" and "Grey-Wooded" Soils.	Intermixed and Transitional Soils: For Black soils occurring as islands see Zone 2 and 3. For Grey soils occurring as islands see Zone 6. } Grey-Black and degrading Black-Earths generally are excellent soils, but they will usually respond to phosphate and legumes (the more grey the soil, the more it will respond to application of organic matter, and to the use of legumes, grasses and nitrogen).			
6—"Grey-Wooded" Soils.	1—Organic matter. 2—Nitrogen, or 3—Nitrogen and phosphate. 4—In addition, local soils may or may not respond to: (a) Potash ± (b) Sulphur ±	1—Fallow not as essential as in the plains area. 2—Intertilled fallow substitutes may be used, especially on light textured soils (light soils leach badly when fallowed).	1—Legumes or grass and legume mixtures in rotation are essential. 2a–General basic fertilizer 16-20 ammonium phosphate* at 60 to 70 pounds per acre. b–After clover try a 1 to 5 acre test strip of grain treated with 70 pounds 16-20 ammonium phosphate plus 50 pounds of potassium sulphate per acre.	1—For roots: Barnyard manure at 15 tons per acr mixed into the soil. 2—For potatoes: Barnyard manure, or apply a co fertilizer such as 9-27-9 at 225 pounds per acre i band application.
7—"High-Lime" (or Rendzina).	1—Phosphate and organic matter.	1—Clover and partial fallow as fallow substitute.	1—Ammonium phosphate* drilled in with the seed at 35 to 45 pounds per acre.	1—Barnyard manure at 12 to 15 tons per acre, rein with phosphate.
7a–"Degrading High-Lime" (or Degrading Rendzina) Soils.	1—Phosphate and organic matter.	As Zone 6 and 7.	As Zone 6.	As Zone 7.



A—Experimental Indications of Fertilizer Requirements:

Experiments in Manitoba have indicated:

(a) That phosphatic fertilizers may be used to advantage generally (with certain qualifications) in both the grassland and forest regions.

(b) That any fertilizer used should contain an increased amount of nitrogen as the organic matter in the soils becomes less, or as the grassland plains give place to aspen grove and forest in the succeeding zones northward.

and

(c) That potash fertilizers do not appear to be commonly needed for general field crops in the grassland region, but they may give local response, especially with certain garden crops and in the forested region.

B*—Choice of Fertilizers:

The commercial fertilizers that are a Manitoba farms include the following:

(a) Phosphatic fertilizers with lower

Superphosphate .....
Ammoniated-phosphate .....
Ammonium-phosphate (Grade B)

(b) Phosphatic fertilizers with higher

Triple Superphosphate .....
Ammonium-phosphate (Grade A)

The analysis figures represent the num per 100 pounds of fertilizer, hence, w any of these fertilizers may be used, rates per acre must be adjusted so that applied.

In the above summary table, unless oth of phosphatic fertilizers recommende higher percentage grades. Where nitr quired, the fertilizers with the highe be used. If in addition, sulphur is req it may be supplied by using the low (which contain gypsum) or if potas mixing potassium sulphate with amm

RACTICES RECOMMENDED FOR THE REGIONAL SOIL ZONES IN MANITOBA

oil Treatment Recommended for—			
ROPS	GRASSES AND LEGUMES	FARM GARDENS	REMARKS
ative ammonium phos- cre applied with ferti- act with the seed.	1—Barnyard manure at 10 tons per acre, applied: (a) Before seeding, or (b) On the Breaking. 2—Make use of snow fences to trap snow.	1—Alternate with fallow in an area (1 to 2 acres) surrounded by a wide grass headland and a windbreak of caragana. (Do not use poplars in this windbreak.) 2—Apply rotted barnyard manure in the fallow year at 10 to 12 tons per acre. 3—Provide a large dug-out for irrigation of the garden.	Moisture is the important determining factor. The combating of drought and the control of soil drifting are the chief soil problems.
per acre (general). 50 pounds ammonium above with fertilizer onium phosphate (but use clover in rotation. ium-phosphate, or 200 side band application.	As Zone 1. Grow grasses and legumes in mixture for soil improvement as a general practice.	Rotted barnyard manure at 12 tons per acre every other year. Use phosphate fertilizer where required to increase seed and bloom at 4 to 5 ounces per 50 feet of row. In drier areas: as Zone 1.	Control of soil drifting is the important problem. On the light and medium textured soils the objective should be to establish field shelter belts, and the periodic or alternate seeding down to grass and legume mixtures should be practised. Moisture conservation is important but not as acute as in Zone 1. Prevention of water erosion is an important local problem.
s per acre in the fall	As Zone 1. 1—Use legumes grown on the arable land to supplement the low grade native hay produced on the poorly drained sites. 2—Improve the grasses grown in the depressions.	1—Barnyard manure plowed in at 10 to 12 tons per acre. 2—To hasten maturity and to improve seed and bloom use ammonium-phosphate applied in bands alongside and at same depth as the seeds, but not in contact with them. Rate—4 to 5 ounces per 50 feet of row.	Prevailing soil is clay-loam in texture. Due to undulating topography, cultural practices for control of water erosion and wind erosion from the knolls is of vital importance.
15 tons per acre well , or apply a complete ounds per acre in side	1a–Barnyard manure applied at 12 to 15 tons per acre prior to seeding. b–At 10 tons per acre as top dressing to hay crops if brush harrowed, or c–On breaking. 2—Use 16-20 ammonium-phosphate at 75 pounds per acre for grass hays. 3—Try mono-ammonium phosphate with sulphate (and potash) to test local requirement for alfalfa.	1—Organic matter required: (a) Use rotted barnyard manure in liberal dressings, or (b) Alternate the garden with clover paddock. 2a–To hasten maturity reinforce with phosphate if manure is used, or b–If after clover, apply complete fertilizer such as 9-27-9 in side band applications.	Grey-wooded soils not suited to continued grain production. Organic matter is low, and downward movement of water causes leaching of plant nutrients, especially in light textured soils. Grass and clover mixtures or alfalfa should be used alternately with general crops to build up soil organic matter. All manure should be saved and applied to the land.
s per acre, reinforced	1—As Zone 6, 1a, b, c, or: 2—Ammonium-phosphate if applied at seeding for grass and legume mixtures. 3—16-20 ammonium-phosphate at 120 pounds per acre for grass hays. 4—Triple superphosphate at 100 pounds per acre every three years to established alfalfa.	1—Barnyard manure reinforced with phosphate, or 2—Barnyard manure at 12 to 15 tons per acre plowed in in the fall, and with ammonium-phosphate or triple superphosphate in side band application at seeding time. 3—For lime induced chlorosis keep organic matter high and top dress with acid peat.	Chief problem is excess of lime and low availability of phosphate. Phosphate deficiency in cattle results if fed exclusively on grass hays, hence hay crops should be fertilized with phosphate, and all feed for cattle should be balanced for minerals as well as for protein, etc.
	As Zone 7.	As Zone 6 and 7.	Somewhat better and deeper soils with less excess of lime in the surface than Zone 7. However they require organic matter and phosphate. Local tests should be conducted with complete fertilizer to ascertain the local requirement for potash.

izers:

ers that are available to supply phosphate for the following:

rs with lower percentage of phosphate (P_2O_5):

	%N	%P_2O_5	%K_2O
.....	0	16	0
hate	2	19	0
ate (Grade B)	16	20	0

rs with higher percentage of phosphate (P_2O_5):

	%N	%P_2O_5	%K_2O
ate	0	43	0
ate (Grade A)	11	48	0

resent the number of pounds of each ingredient izer, hence, where phosphate only is required, may be used, but, for comparable results, the djusted so that equal amounts of phosphate are

able, unless otherwise stated, the rates per acre s recommended are those to be used for the es. Where nitrogen as well as phosphate is re- ith the higher percentage of nitrogen should sulphur is required, usually on degraded soils, using the lower grade phosphatic fertilizers h) or if potash and sulphur are required, by ate with ammonium-phosphate.

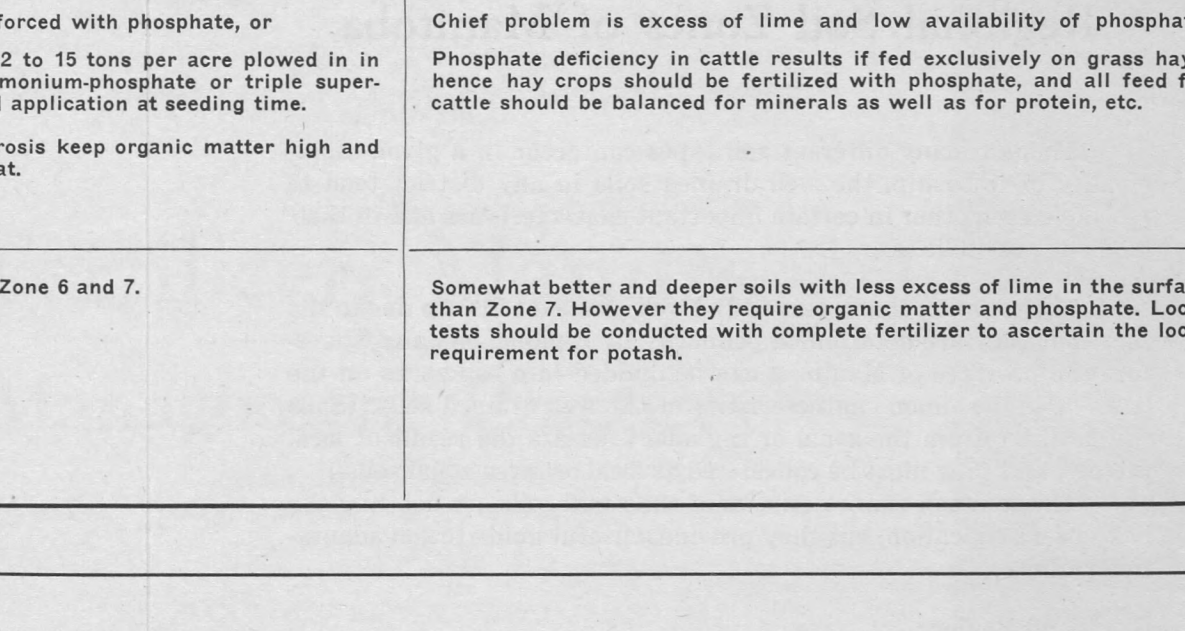
C**—Moisture and Application of Phosphatic Fertilizers to Grain Crops:

Soils must have a favorable supply of moisture if response is to be secured by the use of fertilizer. Phosphatic fertilizers give best results when applied to the crops sown after fallow, and especially if the crops are sown early in the season. They are less effective than barnyard manure when applied to crops sown on stubble land, or on soils somewhat deficient in moisture.

The rate of application of drilled-in fertilizer and the rate of seed per acre should vary with the moisture capacity and with the moisture conditions of the soil. The rates recommended in the above summary table are average applications. Lighter rates should be used on light and relatively dry soils, and heavier rates on heavy and relatively moist soils.

RE FLAX. The rate of application of fertilizer for flax should be one-quarter to one-third or more higher than for the white straw crops, and phosphatic fertilizers with the higher percentages of nitrogen should be used.

CHARACTERISTICS OF TYPICAL ZONAL SOILS IN MANITOBA



Soil Productivity

Crop production in any one season is not the result of one, but of many factors. The crop harvested is determined primarily by the soil, the climate, and the seed or kind of crop; but in addition it must be noted that the maximum returns which might have been secured from the seasonal combination of soil, weather and crop, may have been modified profoundly by the presence of weeds, insect pests, and plant diseases.

Man can determine the crop that is to be grown, and insofar as he controls weeds, insect pests and plant diseases, he protects the crop from injury and thus permits it to make the maximum use of the moisture and nutrients available in the soil under the limitations of climate. Atmospheric climate under field conditions is a variable and is out of man's control. The soils on which the crops are grown are also variable; but in the final analysis it is the condition of the soil which determines the potential productivity or the cropping possibilities, provided of course that the crops sown are suited to the region, and good husbandry practices are followed.

A soil is fertile and productive if it provides favorable conditions for plant growth and satisfies the plant requirements for normal development. These requirements may be listed under a few headings as follows:

(1) The soil must provide a satisfactory medium for the development of the roots which are the plant's intake system.

(2) The soil must provide the plants with water, but at the same time the soil must be reasonably well drained.

(3) The soil must provide the plants with the mineral chemical elements required as nutrients.

(4) The soil must have a favorable reaction, that is, it must be neither too acid nor too alkaline; and in addition, it should not contain an excess of toxic or injurious substances.

(5) The soil should be reasonably free from soil borne diseases.

Thus the ability of a soil to produce is not merely a question of supplying fertilizer. To get the best results from the use of fertilizers and manures, all other limiting factors that can be controlled should be corrected.

(1) The soil as a medium for root development:

The roots are the intake system of a plant. Hence a fertile soil must be of sufficient depth and be in such condition that the plant can develop a satisfactory root system. The greater the depth of soil, the greater will be the possible feeding range. This may be appreciated if it is remembered that the roots of the annual cereal crops extend to a depth of three to four or more feet. Perennial crops like alfalfa will require from eight to ten or more feet of depth for root room. The presence of rock, hard-pan, or dry lenses (layers) of gravel may be responsible for a shallow depth of soil and for the restriction of root room. Moreover, even though the depth of soil may be satisfactory, root development within the soil may be affected by the texture (or size of the soil particles), by the structure (or arrangement of the particles into aggregates), and by the friability and permeability of the soil mass. If the soil is coarse (or sandy) in texture, plants cannot develop such a fine network of roots as they can in a loam or a friable clay loam soil. On the other hand, if the soil is a heavy waxy clay with feeble structure, the pores between the particles may be so fine that root development is restricted. Such a heavy textured clay soil also may break or prune the plant roots as the soil shrinks on drying. It also should be noted that roots develop in moist soils; they will not develop in or pass through a dry layer. Consequently root development may be restricted by a temporarily dry sub-soil.

The growth of a plant is influenced by its intake system. The intake system (i.e., roots) of the plant is influenced by the condition and depth of the soil.

(2) The soil must supply the plant with water:

Plants obtain water from the soil through their intake systems, but it must be remembered that it is only the water which enters into and is retained by the soil that can be used by plants. The seasonal precipitation on a given field for example may be 13 inches, but all of this is not available to the crop. Some of the precipitation falls in such light amounts that it is intercepted by the leaves and evaporates back into the air without entering the soil at all. Moreover, the rain that falls faster than the soil can absorb it will run off, and the greater the slope, the greater will be the run-off. Also more run-off will occur where the soil is less porous. Thus, only a portion of the seasonal precipitation may enter the soil.

Water which enters the soil will penetrate to different depths. depending upon the soil texture. A sandy soil will retain only from

one-quarter to one-half inch of available water per foot; sandy loams will retain one inch of available water per foot; fine sandy loams, one and one-half to one and three-quarter inches; loams, two inches; clay loams, three, inches; and clays three and one-half inches of available water per foot depth of soil. Expressed in another way, if three inches of water entered a well drained clay loam soil it would wet the soil to a depth of about one foot, but if three inches of water entered a sandy soil it would moisten the soil to a depth of two and one-half to three feet. It is obvious, therefore, that different textured soils have a different ability to supply plants with water. If the water retention capacity of the different textured soils is kept in mind, and if we assume that a twenty-five bushel crop of wheat and straw will take from the soil a little more than eight inches of water, it is obvious that even by the best system of summer fallow, sufficient water cannot be stored in the light textured soils to supply the needs of the crop through a long continued period of drought. This is why the light textured soils are droughty and of low value in regions of limited precipitation. In semi-arid regions the heavier textured soils are invariably the more productive because of their higher water retention capacity.

(3) Soils must supply the plant with nutrients:

Plants are complex organisms, designed by nature to build up organic tissues and the compounds which are referred to as starches, sugars, plant proteins, etc., from the chemical elements which are found in the air and in the soil solution. The bulk of the plant material is made from carbon, hydrogen and oxygen which are derived from air and water. Plants also require nitrogen, but with the exception of legumes (which can obtain nitrogen from the soil air by the aid of the bacteria which live in the nodules on their roots), all plants obtain their nitrogen from the soil. Nitrogen in the soil is contained in the soil organic matter. As a general guide it may be taken that one-twentieth of the soil organic matter is nitrogen. Therefore if the organic matter is high, as it is in the black prairie soils, the nitrogen also will be high, but if the organic matter is removed from the soil by wind erosion, nitrogen also will be removed. However, because the nitrogen of the soil is fixed in complex organic compounds it is not available to growing plants until the organic matter is acted upon by organisms and the nitrogen released in an available form.

The activity of the soil micro-organisms is controlled by climate (temperature and moisture). Hence the availability of nitrogen in the soil to plants will depend upon the activity of the micro-organisms, which in turn depends upon the weather conditions. A soil may

be highly fertile as far as being able to supply plants with nitrogen if the soil is warm and moist, but the same soil may be deficient in available nitrogen in a cold backward spring.

The other elements required by plants are mineral elements that are derived from the soil. They include phosphorus, potassium, calcium, magnesium, iron and sulphur, and in some cases traces of such elements as manganese, boron, zinc and copper. These elements are derived originally from the soil minerals, but a portion of such elements as phosphorus and sulphur may be combined with the organic matter of the soil. Mineral elements which are combined in the organic matter are liberated when the organic matter is acted upon by the soil micro-organisms. (See footnote A in summary table.)

(4) Soils must have a favorable reaction:

Cereals and many other agricultural crops will grow in soils which range from slightly acid to slightly alkaline, but for best results the soil should be neither too acid nor too alkaline. Acid soils however are not a problem in the prairie region of Manitoba. Acid soils occur where the mineral elements are leached out of the soil, but alkali soils occur when the mineral salts derived from weathering accumulate in the soil (either because there is not sufficient water to wash them downward or because the run-off water accumulates in the depressions where it later evaporates). In Manitoba, the soils which contain an excess of alkali salts usually occur as a result of the accumulation in the soil of water containing soluble salts; such soils either have impeded drainage or were formerly poorly drained. Well drained soils in Manitoba are rarely ever saline.

(5) Soil should be reasonably free from soil borne diseases:

If the physical condition of the soil is satisfactory for root development, if the soil is moist, if it can supply the mineral nutrients required by the plant, and if the soil solution is not toxic, such a soil will be fertile, but although these conditions may be right, the presence of certain soil borne diseases may sometimes be responsible for the failure of a soil to produce certain crops satisfactorily. The presence of flax wilt or root rot are examples of such soil borne diseases which may be responsible for poor returns from soils which would otherwise be rated as fertile. Such soils might be quite productive if measured by different crops which are not subject to such diseases.

Regional Soil Zones of Manitoba

Though many different soil types can occur in a given municipality or township, the well drained soils in any district tend to resemble each other in certain important characteristics and in their land use possibilities.

The common characters of the well drained soils are due to the fact that they are determined primarily by regional climate. Therefore the province of Manitoba can be divided into soil zones on the basis of the common characteristics of the well drained soils. (Soils which differ from the zonal or regional soils are the result of local factors, and they must be considered as local or intra-zonal soils.)

The common characteristics of the zonal soils are not only the basis of classification, but they provide a useful guide to soil adaptation and use.

Grassland Region:

The soils of the grassland region are the most valuable from the standpoint of present day agriculture because of their general high fertility and their high organic content. These two characteristics are the result of the climate and the grass vegetation under which they were produced. Under the virgin grassland, the mineral matter and the organic matter combined to form the good black earths, famed for their high organic content, for their high nitrogen, and for their granular structure, friability and productivity.

The fact that the original cover was grass rather than trees, indicates that the climate was too dry for forest growth but was sufficiently moist for the production of the prairie and steppe grasses. Moreover, one of the characteristics of the grassland soils, is that an accumulation of lime carbonate occurs just below the dark colored surface soil. The presence of this lime layer shows that the amount of water entering the soils is not sufficient to cause the lime to be carried down into the ground waters. Thus because of climate through the ages, organic matter, nitrogen, and lime accumulated in the grassland soils so that they are generally neutral in reaction, high in organic matter, and highly fertile. Nevertheless, the arable soils have been modified to a greater or less degree due to the effect of continued culture.

Within the grassland region three soil zones occur: the brown-blacks; the black-earths; and the northern blacks. These were formed as a result of differences in moisture and temperature.

Where somewhat drier conditions prevail in the south-western portion a soil zone designated as the brown-black or dark brown black-earth transition soils occurs. The brown-black soils are primarily adapted to the production of high quality wheat. Their high fertility makes them suitable for the production of any crop which can be grown in the prairie region, providing that sufficient moisture is available; but as this zone is subject to the periodic occurrence of drought, the soils are best suited for the production of wheat as the major enterprise, with other types of agricultural production subsidiary and supplementary.

The larger portion of the grassland region in Manitoba is occupied by the black-earth soils. The black-earths are exceptionally high in organic matter, so much so, that the nitrogen content in the better textured virgin soils may be as high as in barnyard manure. The lower depths to the lime layer, together with the higher organic content, indicates that the moisture conditions are more favorable for crop growth. These black-earth soils can be used for the production of a wide range of crops. Grains, grasses, legumes, corn, potatoes, roots, vegetable and many other crops can be depended on to give satisfactory yields under good management in most seasons. Hence, any type of farming could be followed where the textures are good, and where stone or locally impeded drainage does not interfere with cultivation. A portion of this zone contains soils that are light in texture.

The northern black-earth soil zone occurs in the northern portion of the prairie region, where groves of aspen and woodland invasion of prairie proclaim a higher humidity than is common in the more open grassland plain. These soils are also highly fertile, but because the soil climate is cooler and more humid, these soils produce wheat of high yields, but of somewhat lower protein content. This zone is exceptionally good for the production of barley and oats; and somewhat better than average yields of grasses, legumes, roots and potato crops can be expected. These soils also have a much wider adaptation to different types of farming than is being practised, but, because of the difficulty of disposing of other types of produce, the arable land has been used largely for grain production with mixed farming supplementary to the major enterprise.

Forest Region:

To the north of these three soil zones, other soils have been developed (under grassland or under tree invasion of prairie) which occur as islands within the forest region. The good grey-black soils of these intra-zonal areas (such as those occurring in the Dauphin

district and the Swan River Valley), have similar adaptation to the northern black-earth soils.

With a few exceptions, these soil zones and the intra-zonal islands of similar soils already mentioned, account for practically all the land used for agriculture in this province.

North of the prairie and aspen grove region is a vast expanse of soils developed under forest. Here the higher moisture efficiency of the climate has resulted in the development of forest soil types which differ markedly from the grassland soil types. The surface soils below the leaf mat are low in organic matter, and because more moisture passes through the soil than is used by the plants or lost by evaporation, the products of weathering tend to be leached from the surface (except where the forest has developed on material of limestone origin). Hence the surface soils of the forest region are not normally as highly fertile as are the soils of the plains. This does not mean however that they are infertile. The more favorable moisture conditions not only favor the growth of trees, but also insure that high yields of grasses, legumes, roots and coarse grains can be obtained, provided that the fertility and organic matter requirements are satisfied.

In the forest region there is an intra-zonal area between Lake Winnipeg and Lake Manitoba where soils have developed on high-lime geological material, much of which is either too stony or too wet for arable culture, but which may be used for dairying, livestock, and forestry. Scattered throughout the limestone area are local soils which are valuable for the production of alfalfa seed and for mixed farming. The failure to develop the arable soils in this sub-zone has been due in large measure to a lack of understanding of their character. These young, feebly developed soils are characterized by a high lime condition, shallow depth, and low availability of phosphorus. The growing of legumes, and the use of manure or phosphate fertilizer, is essential on these soils.